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ABSTRACT

This publication is the draft record of papers and reports presented at plenary sessions of the International Conference of the International Council of Scientific Unions (ICSU). The theme of this conference was "Education of Teachers for Integrated Science." The papers deal with problems related to preservice and inservice teacher education. In addition to the papers, a 55-item bibliography is included. (PEB)

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THE EDUCATION OF TEACHERS FOR INTEGRATED SCIENCE

(TEACHING SCIENCE FOR TODAY'S SOCIETY)

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This draft report should be read in conjunction with the programme, issued to all participants on the first day.

It was produced before the conference had ended and, inevitably, will contain errors and omissions.

Please inform us of any change you feel should be made in the revised version. Suggestions must reach Peter Richmond at the address below, before 30 April 1973.

P. E. Richmond

Department of Education

The University, Southampton

SO9 5NH, England

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Summary of main points of paper by Harold A. Foecke presented at Plenary Session 2

Integrated Science and Teacher Education- Some Questions and Possible Answers

A major constraint in implementing integrated science programmes is the lack of adequately prepared and competent teachers. At primary level, science will usually be taught, if at all, by a non-specialist teacher as part of the general curriculum: the training problem for this kind of integration may be to give such a teacher the necessary confidence to include science. At secondary level the present generation of teachers regard themselves as subject specialists and hence need encouragement to extend their teaching across the spectrum or to join in team teaching enterprises.

In the development of appropriate training programmes for teachers, there will be two phases: first a transient or remedial phase during which students already trained in separate disciplines are re-oriented, and second a steady-state phase when students are trained from the beginning as integrated science teachers.

But in this context, what do we mean by science? Does it include social science? human science? applied science? technology? The activity that uniquely characterizes science is that of "finding out"; and its greatest contribution to general education is in the realm of "truth seeking." But decision making is one of the most frequent activities in real life and it is in the field of technology that many opportunities arise to make choices. Questions could then be raised about the title "Integrated Science" which might be better replaced by "Science and Technology."

What stages occur when a science course of any type is designed? Suppose we accept the following: (1) specifiy objectives (2) select learners (3) design a programme (4) execute the programme (5) evaluate it (6) choose feed-back loops for modification. Then many questions follow: Who carries out the six steps? What is the role of the teacher? Is he an objective specifier? a materials designer? a learning facilitator? an evaluator? What skills, attitudes, tasks, concepts, etc. does a teacher of integrated science need? What are the effects of external factors such as local tradition and legislation?

Perhaps the three areas where innovation is most needed are:- (1) New ways of teaching science to teachers (2) New ways of helping them acquire the necessary skills for teaching science (3) New ways of evaluating the effectiveness of the methods used.

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Summary of main points of paper presented by Victor Showalter in Plenary Session 2

Desirable Characteristics of Teachers of Integrated Science

A teacher of integrated science needs all the characteristics of a teacher of any science but he needs more than these: This paper considers some of the additional ones. Unfortunately, the very nature of many current teacher-preparation programmes tends to block the successful development of desirable characteristics and one of the main functions of this Conference should be to propose alternative ways.

The unique characteristics of an ideal teacher of integrated science can be grouped under three headings:

1. The teacher's personal philosophy should acknowledge the unity of science and accept that the specialist sub-divisions of science are arbitrary although they can sometimes be useful to scientists. Various factors permeate all sciences and these should form the basis of the liberal education for all people. Among these factors are: The set of values that characterize science, the idea that everything in the universe is part of the same universe, the fact that most theories of knowledge assign science to a special category that differs from some subjects but that they rarely distinguish between the arbitrary separate sciences. Similar processes and terminologies crop up in many different areas and can be sufficiently well understood by the specialists to provide a unifying influence. The same is true of concepts and constructs such as equilibrium, model, system etc. all of which can be understood by any scientist.

2. The personal life style of the teacher of integrated science and of any science reflects his philosophy. What is learned is really the philosophy of the teacher as experienced in the way he conducts the class. This is an aspect of Marshall McLuhan's dictum "The Medium is the Message." The classic example of "how not to" is the tedious and lengthy lecture on the evils of the lecture. A desirable characteristic under this heading is a willingness to encourage and value questions in all things and a readiness often to respond with "That's a great question; I don't know the answer but let's get together to find an answer."

3. An awareness of the nature of the learners of the learning process should lend the teacher of integrated science:

   (a) To use a mixture of teaching methods as opposed to only one.
   (b) To advocate an evolving curriculum that over the years will change in response to the needs of students and society and to improvements in the school's technical facilities.
   (c) To regard the learner as on a par with science itself in shaping the science curriculum.
   (d) To cooperate with colleagues at local and, if possible, national and international levels to improve science education.

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Summary of main points of paper by Sheila M. Haggis presented at Plenary Session 2.

Integrated Science and the Science Teacher

During the four and a half years since the Congress on the Integration of Science Teaching was held in Varna, Bulgaria, in 1968, we have witnessed a shift in emphasis from the "what" and the "why" of integrated science teaching to the "how". Integrated science teaching projects are now found all over the world and a wide range of different approaches to integrated science teaching have recently developed. These include "process", concept," "unit," environmental," "applied science, "thematic, "project, and pattern.

UNESCO's programme in integrated science teaching has been launched in response to the widely-felt need that science education should form part of the general education of all pupils.

During the last forty years, the transition from "general science to "integrated science" has been influenced by developments in the nature of the scientific enterprise itself, on the one hand, and by developments of large-scale curriculum projects in the science disciplines on the other. Today, the aims and objectives of integrated science courses reflect the nature of science, the nature of the learners and the nature of society.

It is notorious that teachers teach as they themselves were taught, but to teach integrated science, they must depart from this pattern. Society expects teachers to have answers, but effective teachers of integrated science will not always have the answers and must be prepared to say "I don't know". The teacher of integrated science is thus confronted with the need to make a major change in his teaching approach. He will ask "why should I use the new approach?", "how can I do it?" and "how can I gain self-confidence? It is to these questions that this Conference must address itself in an endeavor to indicate some possible solutions.

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SUMMARY OF PAPER PRESENTED BY M. J. PENTZ AT PLENARY SESSION #3

Open University Courses in Science and Technology Applicable To the Education of Teachers of Integrated Science

The Open University's courses are based on a credit system in which one credit represents about 360 hours of study spent over a 42 week academic year together with about 60 hours work at a one-week residential summer school. A degree demands either six credits or eight credits and, since most of the science and technology courses have half-credit rating the range of flexibility of combinations is considerable.

It seems self-evident that these courses can contribute to the education of teachers of integrated science in two ways. One is to provide the teacher with something to integrate; if he has only learned biology he can hardly be expected to teach biology, chemistry, physics and earth science whether integrated or not. The other way is to offer him courses which are themselves integrated. The opening paragraphs of the Introduction and Guide to the Foundation Course read as follows:

> 'One of our aims in designing this Course was that it should be an integrated multi-disciplinary course, with contributions from physics, chemistry, biology and Earth Science, but linked together in such a way as to demonstrate the unity of science as well as its diversity. We try to show what is common to all the disciplines as well as what is special to each. This has seldom been done before at first-year undergraduate level. Another aim was to teach science in its social context-to bring out clearly the relationship between science and society. Again, this is breaking new ground. A few universities in Britain offer special courses about Science and Society, but none attempt to teach the main science courses themselves in this way.'

The achievement of these aims is sought by giving the course structure which emphasizes the inter-relationship and internal unity of science and makes as explicit as possible the distinctive roots and social relations of science. For example, the first unit begins by tracing the emergence of science and scientific method in man. Science is seen as a human activity developing within a particular technological and social context and interacting with it.

The primary aim of the Technology Foundation Course is to explain what technology is, how it operates and how it interacts with the life of the community. Thus, it too is concerned with the internal logic and the external relations of the subject.

Inasmuch as the history, ideology and social relevance of science derive from the threefold interaction between science, technology and society, it seems plausible to suggest that a course in technology, if it is properly designed, could be of value to the teacher of integrated science.

Many of the second-level science and technology courses that have been produced in the Open University so far have similar characteristics to the Foundation Courses-they are multi-disciplinary in content, integrative in approach and relate the subject to the social context.

It may thus be concluded that science and technology courses of the type being taught in the Open University could make a significant contribution to the education of teachers of integrated science. Large numbers of teachers are studying these courses. Whether their studies do in fact affect their abilities to teach integrated science is a matter of research. This research has yet to be undertaken.

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Summary of Paper Presented by Kevin W. Keohane at Plenary Session #4

PRE-SERVICE EDUCATION OF TEACHERS OF INTEGRATED SCIENCE AT TRAINING COLLEGES AND UNIVERSITIES

Perhaps the most important question that can be raised in this session is whether we really wish to educate teachers for teaching of Integrated Science or would it not be more appropriate, at primary levels in particular, to encourage an approach to science integrated within teaching of the whole curriculum? The change from 'being told' to 'finding out' occurred first in art, then in physical education, English and Mathematics and only later came the idea of discovery through the child's experiences of his own natural environment. It is almost a pity that we even use the word 'science' for the activities, essentially investigatory, of children in the early age ranges.

The task of educating teachers is vast and complex and yet it is possible to identify certain central principles, an appreciation of which should be developed in any progressive programme of teacher education.

(a) the essential need for children to have first hand sensory experience.
(b) the needs of each individual, to be recognised and compensation given for the varied and often limited experiences of the child in the home or society outside the school.
(c) the problems associated with the formation of concepts and the ways in which the process can be made easier by providing suitable situations.
(d) the need for an extended vocabulary arising from the experiences gained by the child.
(e) the relative difficulty of different ideas.
(f) the delay in response which often accompanies experiences.
(g) the awareness and absorbing interest in detail that can develop in children.
(h) the classroom organization which creates the best possible conditions for learning.
(i) the part that discussion can play in enabling children to find things which interest them most.

By identifying some of the essential conditions for the practical education of teachers it becomes possible to ensure that the preparation is adequate for the integration of scientific activities into the whole curriculum and that it can serve a range of entrants to a teaching career.

Attempting these tasks the teacher educator is faced with a problem of converting students to modern ideas and practices in education. Furthermore, in the content of Integrated Science he has to coax the student into a confidence to handle and manage learning in scientific field beyond his specialist experience. The initial period of training, often no more than a year, can only hope to make a start which induction and re-training opportunities will sustain and develop.

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SUMMARY OF AN ADDRESS BY GREGORY RAMSEY, PLENARY SESSION 5

In-Service Education of Teachers of Integrated Science

Expensive science curriculum projects have produced excellent materials but, as yet, too little attention has been paid to improving the capacity of teachers to use the materials effectively. In-service education must be a planned extension of pre-service education if the enthusiams of the young are to be maintained and strengthened by the experience of serving teachers.

Teachers of different subject backgrounds should work together and consider the benefits of moving from separate sciences to unified science or perhaps to general studies. They can together discuss their problems: low literacy, poor facilities, or consider the potential of their environment - town or country, seashore or bush.

Teacher educators can make additional contributions by helping the teachers to understand psychological and social aspects of their pupils and the nature of scientific activity and its social significance. It is difficult for teachers, busy each day with immediate tasks with students, to observe and comprehend the transitions which science and society are experiencing. They need to work in teams and to become aware of what is available outside their own school, outside their own subject and outside their own teaching experiences.

Conditions need to be created such that a teacher, having had exciting, challenging experiences outside his own field or school will be accepted and encouraged when he returns. Pre-service education should be planned to be incomplete and planned to continue in a number of different ways. The Open University in England provides opportunities at home - so do self-instructional materials. Schools themselves can and do provide continuous in-service opportunities for their staff and this is less expensive than taking teachers out of schools for in-service courses at College or University.

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SUMMARY OF PAPER PRESENTED BY MYRIAM KRASILCHIK TO PLENARY SESSION NO. 6.

Evaluation of Programmes for the Education of Teachers of Integrated Science

A sequel to the movement that changed the picutre of science teaching all over the world during the sixties is an increasing concern about the efficiency of systems of teacher training, institutions and courses. As new curricula were introduced - for example, PSSC, CHEM, BSCS, etc. - summer and in-service courses were started but, on balance, they changed the content of the courses but not the teaching style. Now, as well as learning new ways of teaching, teachers of integrated science need to take a new look at science as a whole - and the resistance is considerable.

Much money, time and energy have been expended on innovation and it is right that we should ask what the real results have been. Now we see that we must begin to ask questions as soon as a new course begins - not after fifteen years. Evaluation is an urgent need and the question "How does one evaluate good teaching?" and more particularly "good integrated science teaching" must be faced.

What is good science teaching? To answer this we need first to produce a list of behavior patterns that teaching should require. We cannot predict the behavior of a teacher from his grades in his training course and some element of evaluation will have to wait until he is already teaching in a real situation. We need to ask questions such as "Can a short in-service course change a teacher's behavior?" "Is teaching better when a curriculum package is used?"

A major problem is that of human resource. How can we recruit and train evaluators? Could social scientists be used and if so what training would they need? It is vitally important that consultants and evaluators work from within about situations they really know and understand. Authorities and institutions in charge of training programmes tend to be unaware of the needs. In educational statistics it does not sound as successful to say that a programme is "good" as to say that "thousands" are following it. Ways of sharing and disseminating evaluation procedures, problems and ideas are needed to give small groups the confidence to begin.

The main advice, however, is not to wait till all the resources and materials are available but to <u>start</u>, in no matter how crude or homemade a fashion. There will then be a continuing basis of evaluation which will provide evidence for development and for obtaining further resources.

During the discussion there was much agreement that although this topic was set in a Latin-American context all the problems were just as relevant to the most highly developed countries. The advice to get started in however crude a way was endorsed by several speakers as was also the need for the evaluators to be people already involved in the training or doing of whatever is being evaluated. There was a strong appeal for the value of subjective human judgement as an evaluation method to be given its proper place and for teachers in training to be given the confidence to use it.

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Summary of Paper Presented by John Maddox at Plenary Session 7

THE SOCIAL RESPONSIBILITY OF SCIENTISTS AND THE RECIPROCAL RESPONSIBILITY OF SOCIETY

To the extent that science ranks with other kinds of intellectual activities as a means for the potential improvement of society, it is natural to ask just how science should be organised so as to be most useful. This is the best starting point for the definition of social responsibility. But many discoveries are potentially harmful as well as beneficial, and so the question arises whether scientists should not refrain from working on potentially harmful projects. One themsof this lecture will be that scientists have discharged their responsibility to science if they spend more energy on anticipating the consequences of their work and in communicating these to society at large, not merely the governments which frequently employ them. And society, especially governments, have the reciprocal responsibility of being prepared to receive and to digest advice of this kind and to make intelligent decisions about the applications of science. Scientists also have a responsibility to ensure that the work they do is intellectually adventurous, and society's reciprocal duty is to ensure that the necessary funds and resources are available.

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Summary of main points of a paper presented by John Goodlad - Plenary Session 8.

INTEGRATED SCIENCE, TEACHER EDUCATION (AND THE IMPROVEMENT OF SCHOOLING)

Concentrating only on improving the curriculum--whether or not integrated--will not suffice in seeking to make our schools exciting, viable educational institutions. We must carry our discourse and our actions to the whole of schooling: what is to be included in the curriculum, how the school is to be organized, the persons who teach there, and the ends towards which the whole is to be directed. Few curriculum projects include this range of considerations and, as a consequence, few find their way behind school and classroom doors to make a real difference to the learning that goes on there.

Schools have very little time for effecting significant differences. By age 13, children who have been in school for 7 years have spent only 6.6% of their lives there. Clearly, then, schools cannot assume many burdens. They should seek to do a few things well. Consequently, teachers must transcent the narrowness of their disciplines to assume larger roles of improving the total environment of the schools in which they work and future teachers must be prepared for such roles. If one is to become seriously and productively engaged in seeking to change any part of the school's program, he must become involved in the school as a functioning social system.

From 1966 to 1972, my colleagues and I became involved in developing and studying a strategy for educational change designed to increase the potency of schools. The project was based on the premise that the individual school is the key unit for educational improvement. Our findings suggest that focusing on the total social system of the school as a way to effect improvement is very encouraging. There is no question that most of the teachers become seriously engaged in their work to a degree not previously evident. Second, there is no doubt that they concerned themselves with significant questions of educational ends and means. Third, there is ample support for the proposition that involved, enthusiastic teachers arouse the support and participation of parents. Fourth, the kinds of changes that have been so much recommended in recent years--individualized instruction, the adoption of revised curricula, nongrading, team teaching, etc.--were intoduced in most of the schools with little fanfare. These simply proved to be rather natural responses to the ongoing search for better ways. Fifth, even casual observation reveals that the spirit of involvement and commitment carried over to the children, especially at the primary level (K-3) where the kind and intensity of student activity was impressive. Sixth, on measures of attitude toward school, boys and girls in League schools responded more positively than pupils in control schools.

Curriculum reform affects nothing if it fails to reach the students. It will affect students very little if only the substance of new materials reaches them. If curriculum reform is to make a substantial difference, all of its ends and means must get through school and classroom doors. This has a reasonable chance of happening when the school is a self-renewing, responsive agency. Making it so is demanding, neglected work to which school faculties must turn and in which curriculum makers must participate.

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Summary of Plenary Session 8 by Maurice Goldsmith

THE SOCIAL SIGNIFICANCE OF THE TEACHING OF SCIENCE AND MATHEMATICS IN THE COMMONWEALTH

I see integrated science teaching - however defined, whether as an integration of science subjects, or an integration of science with other non-science subjects, as historically inevitable. Nothing less will do now at a time when the old rules no longer apply, and when uncertainty in social and political senses is our daily companion.

A new paradigm is being born: it is up to us to understand this, and to act as midwives so that the new birth will come with joy and not with suffering.

Science itself for many years past has been one: the great unifying principles of this century have shown that the divisions into physics, chemistry, and biology are man-made, dictated by temporary historical needs. Only in the classroom do they linger on, linked to a deadly examination system which poisons the wells of creativity.

"Limits to Growth is fashionable in discussion. But there is another limit to growth which is not mentioned. It arises from the fact that we have exhausted the intellectual wealth that was contained in the curricula and institutional forms which were established a hundred years ago. But unlike fossil resources, the human mind can renew itself and reveal new riches. However, this needs a new orientation.

An attempt to formulate this for Science and Mathematics was made from 29 March to 2 April at a Conference of Commonwealth Countries on the theme of "The Social Significance of the Teaching of Science and Mathematics." Forty people from these countries were invited to meet on the Mona campus of the University of the West Indies at Kingston, Jamaica.

Education has tended to emphasize skills and knowledge. We wanted to achieve a better balance by paying much more attention to desirable attitudes when devising new school curricula and we agreed to regard the Social Significance of Science and Mathematics Education as being measured by its potential as a social vehicle to fit children into society, providing equality of opportunity for happiness.

We agreed that ... It is for the individual nation to formulate its national goals and objectives and to interpret these in terms of curriculum content and approaches. In formulating such goals however, there are many clear trends in national development, which have a strong scientific or technological content and which are an inherent part of the structure of a modern nation state. This is true whether the economy of such a state is based upon agriculture or industry in a broader technological sense. These trends will in time produce effects on the structure and nature of the society within the state, either at national, community or individual level. Examples are in health, medicine and hygiene, changes in patterns of communication and transport either of persons or of information, etc.

We asked two major questions. What can education through Science and Mathematics do <u>for</u> society? And what can education through Science and Mathematics do <u>to</u> society?

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Report of Working Group A on New Approaches to the Preparation and In-service training of teachers of Integrated Science, including the teacher as an Evaluator of student learning.

Chairman: P. Fensham, Australia
Rapporteur: D. W. Harlow, U.K

The group was composed of about 60 people from 36 countries, who originally indicated that they would present some 38 papers. Clearly we had a talented group with some useful ideas to exchange. Five sub-groups were formed to suggest MODELS for (i) the pre-service training of secondary teachers (iii) the in-service training of secondary teachers (iv) the action necessary by regional administrators, headmasters and heads of science departments and (v) the teachers as an Evaluator. In our final report we will include suggested models for each sub-group, but here we will only illustrate the areas of discussion by a few 'first generation' models. Some time was spent by each sub-group in attempting to find a satisfactory definition of integrated science. The UNESCO definition accepted by the pre-service secondary group resulted in Model A.

This latter model is designed to help define the major needs of the teacher of integrated science. Many facets of the complete requirements of a good programme were considered and will form the basis of the main report but the group wishes to emphasize that any programme must give an appreciation of the social significance of science in the world in which we live. What is socially significant will largely depend upon conditions of the local region.

For the in-service training of secondary teachers, these models were analysed. Another model, prepared by the sub-group on Evaluation, shows delineation of a number of characteristics which arise directly from the nature of integrated science teaching.

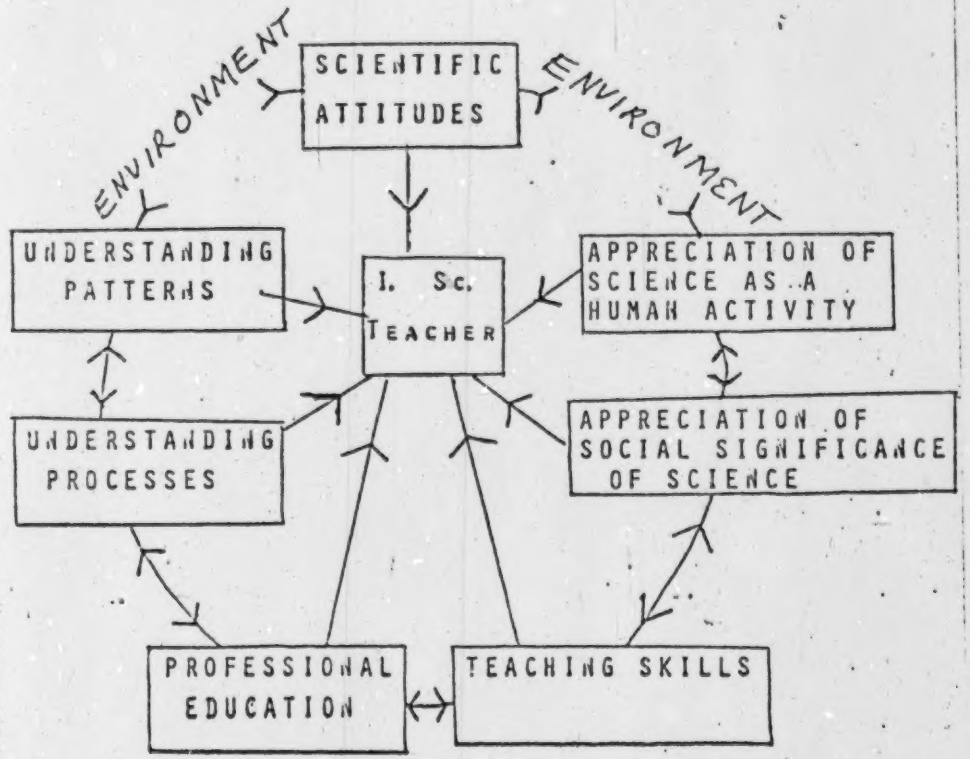
It was decided that it would be unrealistic to separate the pre-service and in-service at the primary level. Great benefit can accrue from having experienced teachers mingling with students. Their considerable knowledge of actual teaching conditions can be reflected in the manner in which the training process can pay special attention to (i) the characteristics of the local environment and (ii) the instructional resources and constraints. A model will appear in the final report.

The primary group was also able to pay attention to some Competencies required from the teacher of integrated science. These will be listed in the final report.

As an adjunct to all teacher preparation, a sub-group considered elements in educational systems that must be involved if changes in teaching are to be effected. The flow of communication between these elements and the changes in their existing behaviour that must occur were discussed. Appropriate models from five developing countries will be included in the final report.

Some of the factors discussed by the sub-group of administrators form the material for the final model B.

PRE-SERVICE PREPARATION OF INTEGRATED SCIENCE TEACHER - HIS/HER NEEDS



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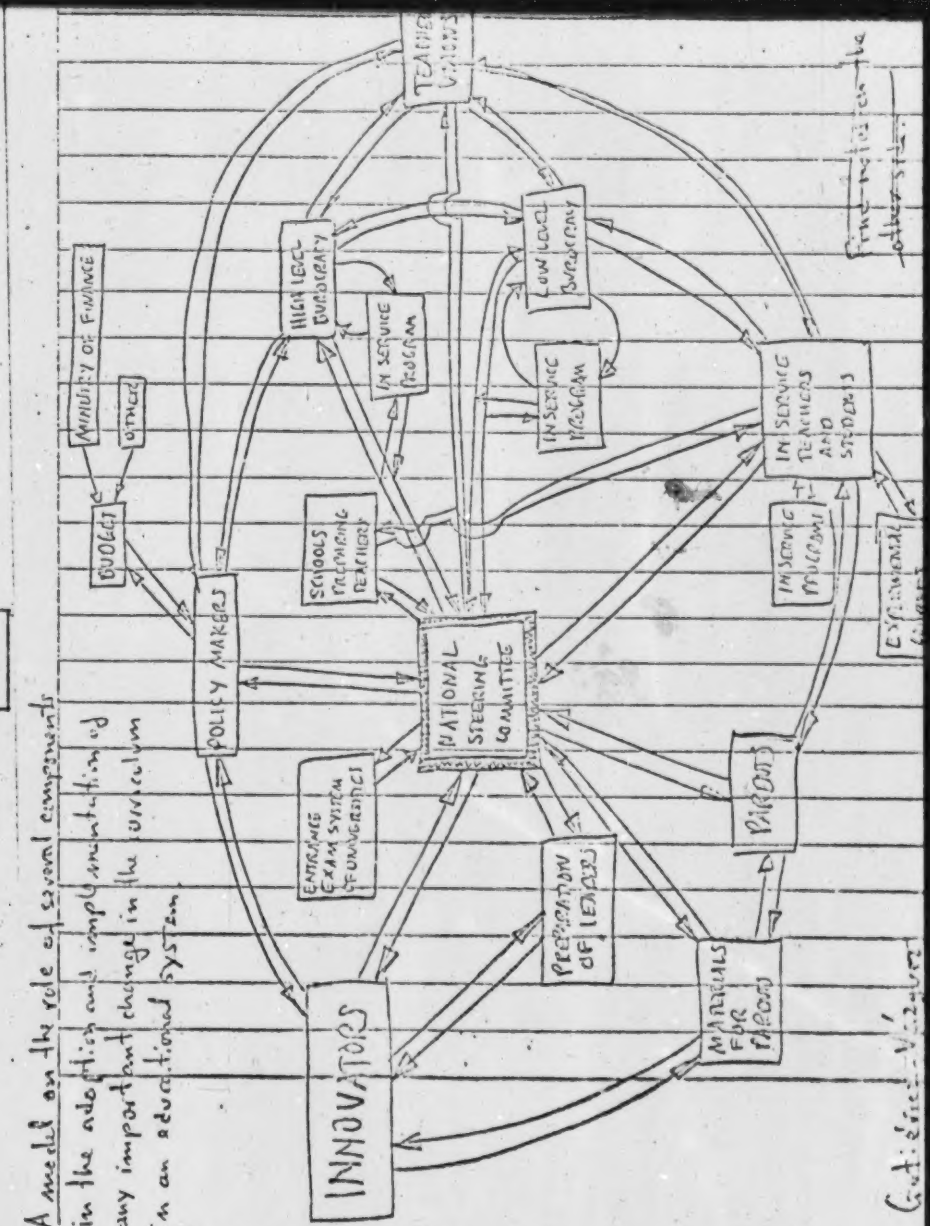
A model on the role of several components in the adoption and implementation of any important change in the curriculum in an educational system



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Working Group Wb Chairman: Dr. C. Sutton Rapporteur: Prof. E. A. Miller

New materials for the education of science teachers and the role of laboratory experience in the education of science teachers.

We dealth mainly with the following four questions:

A. What is available now?
   (with examples of how and where it is being used)
B. What else is needed?
C. How can it be obtained?
D. How can it be invorporated in courses?

In the preliminary discussion we considered the distinction between materials
   (a) to improve the teacher's knowledge in science, their teaching skills, or their attitudes,
   (b) to be used in
      (i) pre-training teachers — with little or no knowledge in science
      (ii) re-training teachers — with some knowledge of science.

These distinctions were kept in mind in the work that followed but did not restrict it.

For efficient working, the materials were divided into the following types which were investigated by separate teams:

1. Apparatus
2. Printed course material for elementary and middle school teachers (middle school = junior secondary)
3. Printed course material for secondary school teachers
4. Audiovisual materials
5. Published aids and guidelines for organizing teachers' courses.

We have compiled annotated lists of materials that are now available in each category. The evaluation results will be published in the full report of the conference. For categories 1, 4, and 5 significant progress has been made in identifying what else is needed and how it could be obtained.

Some of the conclusions of the working group Wb as a whole are the following:

- It was agreed that the making of equipment should be included as an exercise during pre- and in-service training of teachers, but that the teacher should not be regarded as a source of supply of equipment for the regular training programme in the schools. During training, the teacher should be given opportunity to use all equipment commonly used in schools as well as a variety of other apparatus to enrich his knowledge and experience.

- It was recommended that each country should develop its own materials according to its needs. One should avoid imposing a program which may be good in one country onto another country. However, all good and useful materials from various countries should be secured to provide background, examples of good practice and even pilot testing for the work of local science education groups in any country.

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- A problem is that some teacher might follow the instructions of a given program literally without understanding the principles of it. This could easily lead to misinterpretations. Solutions to this problem may be, for example, the following:

(a) Traveling supervisors who work with groups of teachers or individual teachers;
(b) Teachers' centers containing a pool of resources adequate for the area;
(c) Selection and modification of some existing programs;
(d) The production of simple and clear self-instructional material for teachers.

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GROUP Wc -- SCIENCE TEACHERS ASSOCIATIONS, SCIENCE INSPECTORS, AND ADVISORS
(APRIL 7, 1973)

CHAIRMAN: S. ADU AMPOMAH RAPPORTEUR: B. THOMSON

INTRODUCTION

We all set out in different directions to look closely at the ways associations, senior science teachers and inspectors could work toward the goal of an integrated science curriculum. Although working groups selected specialized areas to pursue, common problems were identified despite variations in the organizational structure of various countries. The diagram below illustrates this interrelationship and the narrative part of the report identifies the tasks which could be carried out to implement integrated science.

DEFINITION OF TERMS

1. Roles
   Function
2. Senior science teacher, chairman of a science department, and head of a science department are used as synonyms
3. Supervisors and inspectors were viewed as having similar functions
4. Integrated Science - agreed upon the UNESCO definition.

DISCUSSION

Although each of the three areas discussed have distinct roles, they also have many similar roles. It is useful to identify the differences and similarities and then proceed to ways of cooperating to meet the same goals. The formulation and implementation in the schools will need the help of all three of these areas, i.e. senior teacher, inspector, and associations.

The diagram which accompanies this summary is a composite of inspectors, senior teachers, and associations. In some countries the emphasis occurs in certain categories while other countries have their emphasis in other areas. By identifying a composite situation, this model can be used to look more objectively at the roles within each country. Perhaps it will be easier to see ways to establish new roles when moving into an integrated curriculum.

This committee was concerned primarily with inspectors, associations and advisors and acknowledges through the diagram other influential roles.

Use this diagram as a model to discuss the educational system of a country and identify ways associations, inspectors, and senior teachers can implement an integrated science program using their roles as effectively as possible.

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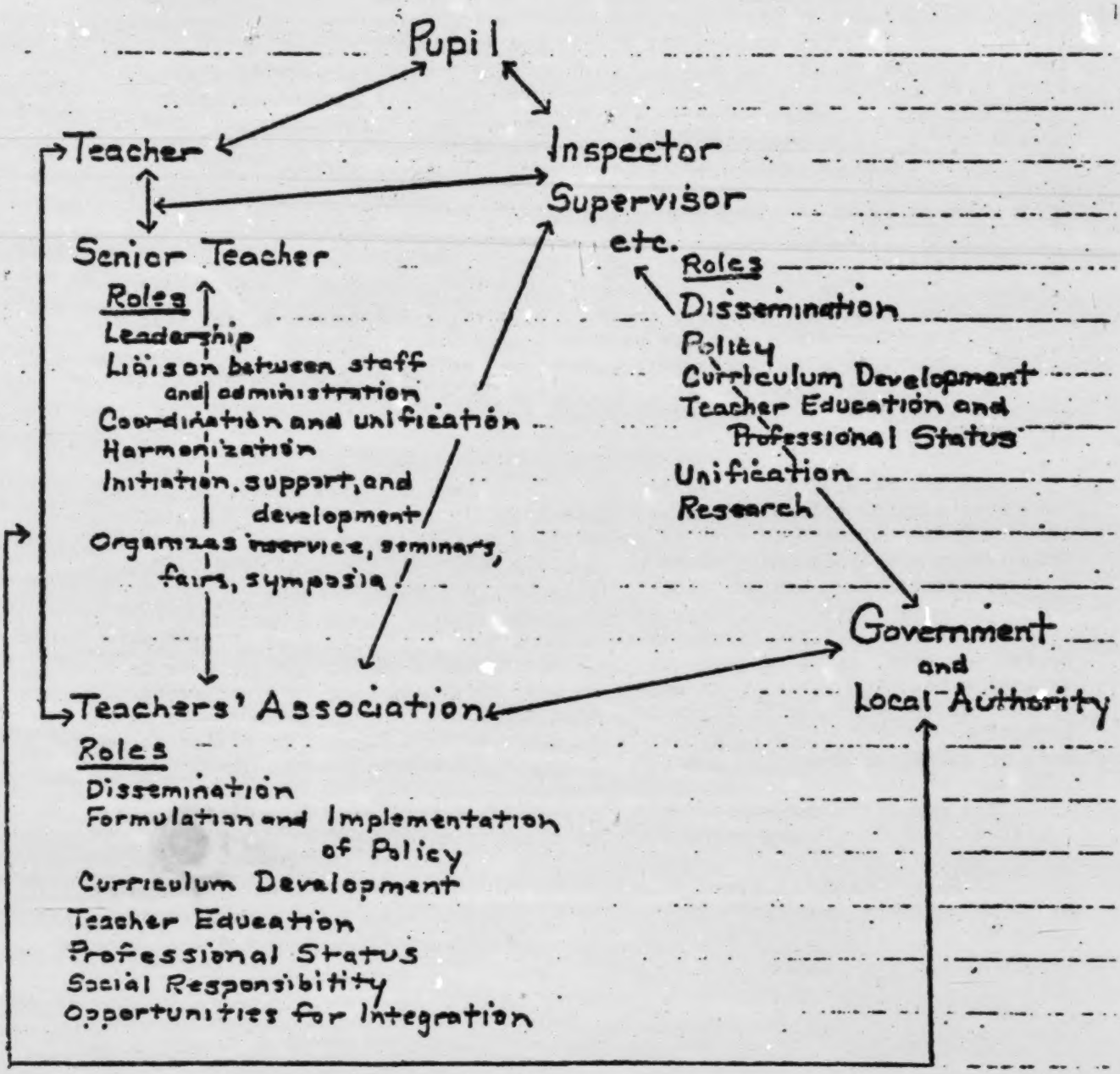

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CHAIRMAN: S. ADU AMPOMAH RAPPORTEUR: B. THOMSON

INTRODUCTION

We all set out in different directions to look closely at the ways associations, senior science teachers and inspectors could work toward the goal of an integrated science curriculum. Although working groups selected specialized areas to pursue, common problems were identified despite variations in the organizational structure of various countries. The diagram below illustrates this interrelationship and the narrative part of the report identifies the tasks which could be carried out to implement integrated science.

DEFINITION OF TERMS

1. Roles
   Function
2. Senior science teacher, chairman of a science department, and head of a science department are used as synonyms
3. Supervisors and inspectors were viewed as having similar functions
4. Integrated Science - agreed upon the UNESCO definition.

DISCUSSION

Although each of the three areas discussed have distinct roles, they also have many similar roles. It is useful to identify the differences and similarities and then proceed to ways of cooperating to meet the same goals. The formulation and implementation in the schools will need the help of all three of these areas, i.e. senior teacher, inspector, and associations.

The diagram which accompanies this summary is a composite of inspectors, senior teachers, and associations. In some countries the emphasis occurs in certain categories while other countries have their emphasis in other areas. By identifying a composite situation, this model can be used to look more objectively at the roles within each country. Perhaps it will be easier to see ways to establish new roles when moving into an integrated curriculum.

This committee was concerned primarily with inspectors, associations and advisors and acknowledges through the diagram other influential roles.

Use this diagram as a model to discuss the educational system of a country and identify ways associations, inspectors, and senior teachers can implement an integrated science program using their roles as effectively as possible.

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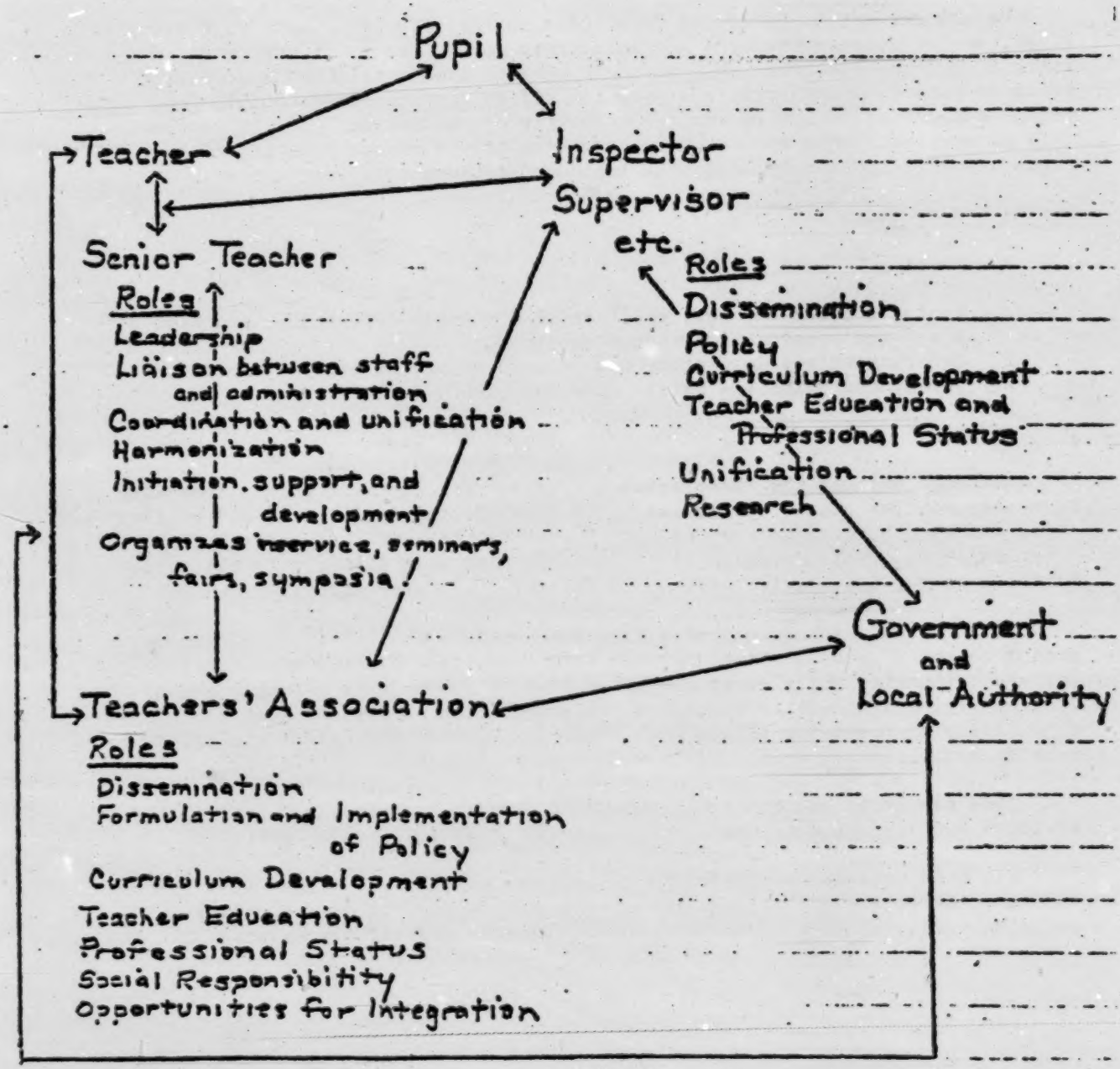

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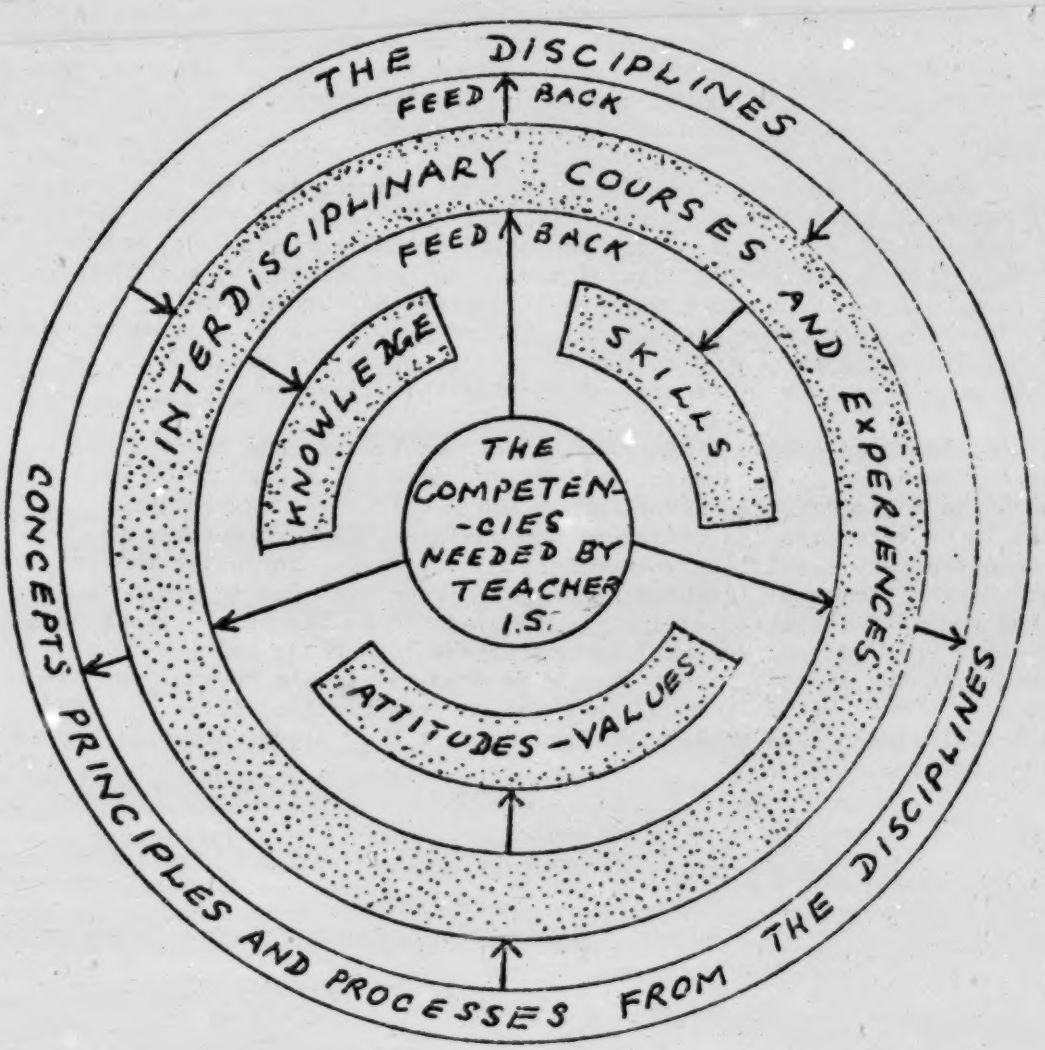
Working Group Wd Chairman: Jean D. Grambs
Rapporteur: Arthur Torrie

CONTRIBUTIONS OF COURSES AND EXPERIENCES OTHER THAN THOSE IN SCIENCE AND SCIENCE EDUCATION TO THE EDUCATION OF THE TEACHER OF INTEGRATED SCIENCE

MODEL



Competencies needed by the teacher of integrated science in the modern world go far beyond the boundaries of conventional science education. He requires additional knowledge, attitudes, and skills which will enable his students to interpret for themselves the role of science during a period of rapid social and technological change.

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The disciplines on the outer rim of the model contribute in varying degrees to the desired competencies needed by the future teacher of integrated science. However, the teacher-trainee in the universities and colleges has traditionally been concerned with gaining competencies in science subjects to the exclusion of desirable experiences from other disciplines. Therefore, an imaginative programme of interdisciplinary courses and experiences needs to be devised to develop the knowledge, attitudes, and skills required for the competent teacher of integrated science.

It is expected that continuous communication between student-teachers and faculty would bring about modifications from time to time in the progressive development of the program. Furthermore, it is important that feed-back should also be obtained from pupils in classrooms staffed by teachers trained along lines suggested by the proposed model. Follow up of such teachers is essential. Methods should be devised for involving community and special interest groups in helping to evaluate and contribute to the development of innovative teacher education programs such as the model suggests.

One example of an interdisciplinary teacher preparation which is consistent with this model is found at the University of Wisconsin's Green Bay campus where all degree programs are organized around environmental problems rather than around traditional disciplines. The development of social responsibility as well as technical expertise is emphasized through a wide range of problem-oriented courses which cross disciplinary lines as well as through a variety of experiences in which the student is given the opportunity to apply his knowledge in real situations outside the classroom.

Officials in education ministries, education bureaus and their staff must be informed and their support solicited. Strategies need to be developed to launch the new programmes suggested in the model; these may include pilot projects in universities and colleges; new administrative structures to facilitate the interdisciplinary cooperation; strategies to assist the production and disemmination of teaching materials; procedures for informing and involving the academic staff of institutions educating teachers. Programmes and models should reflect cultural and religious conditions and should be organized with the awareness that they vary from one locale to another. It must be emphasized that this model is in no way restrictive; it is expected that other similar models will be devised to meet the unique circumstances of different nations.

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THE EVALUATION OF PROGRAMS FOR EDUCATION OF TEACHERS OF INTEGRATED SCIENCE

Paul DeHart Hurd, Rapporteur
Stanford University, U.S.A.

Summary

Working Group We

Limits to effectiveness of implementation of integrated science teaching are imposed by the quality of teacher education programs, both pre-service and in-service. Yet, as it is with nearly all problems within the educational enterprise, there is no one best way for implementing change. Expectations, guidelines and models can be described; the successful experiences of other countries can be explored; but most important are the actions taken in local schools and colleges. The most vital point in evaluating teacher education programs is that progress is being made on all fronts toward the objectives which have been accepted for an integrative approach to science teaching. These objectives will vary from one context to another; for example, according to levels (primary, secondary, tertiary), national developmental stages (developing and developed nations). Consequently, recommendations concerning the evaluation of the effectiveness of teacher education programs will need to be flexible enough to take account of these differences.

Nevertheless, it appears basic to the effectiveness of programs for the education of teachers of integrated science that they ensure competencies in the subject matter, teaching methods and attitudes concerning integrated science. Specifically, basic science courses will need to be organized and taught in an integrative mode. Methods courses will need to stress ways of presenting science in an integrative and social context. Most of all teachers will need to appreciate the worthiness of integrated science teaching.

The initial efforts to devise teacher education programs for integrated science must of necessity be reflective -- "A preliminary screening of the curriculum components to decide their suitability in terms of the goals of integrated science." Formative and summative evaluations which follow will be more tedious because valid and reliable measures are not available. ICSU and UNESCO are encouraged to support a research program for the development of evaluation instruments of the variety essential for assessing the many facets of integrative education.

REPORT ON WORKING GROUP Wf.

Working Group Wf was made up of 41 persons representing 28 countries. A survey of their interests indicated Primary/Elementary 7, Secondary 23, and College/University 12.

During the first working session and prior to discussions participants were asked to write down up to three goals which they thought were of most importance for teachers of integrated science. A grouping of several items from this survey showed:

Competancy in integrated science	19
Overall relationship of science to school and society	15
Flexibility and creativity in approach	14
Ability to convey competance to students	13
Methods (attitudes, Humanistic approach)	12
Provide experiences and relate to child's intellectual development	9

About six others were listed 1-3 times. One of significance was that only one person suggested a team for integrated science.

Wf was then divided into four sub-groups. No particular basis for division. Participants joined with the group leader of their choice. The topic they were given was: "Identify the overall goals of teacher education for integrated science." *

After one work session in sub-groups, group Wf reformed to pool and discuss their suggestions. One sub-group requested to continue on with their original plan on overall goals and continued to do so through the next three work periods. The other three groups worked towards objectives at various levels of the education system, primary, secondary or tertiary (or higher education).

The group which continued to work on overall goals expanded their plan and took into consideration some of the earlier suggestions made by the other groups. Their final outline:

Major Classification

1) Pre-service objectives
   a) Common objectives for all teachers
   b) Specific objectives for Science teachers
      1) Objectives concerned with teaching
         examples methods experiences
      2) Objectives concerned with the discipline of I.S.
         examples
         experiences
2) In-Service training objectives
   examples
   experiences

Pre-Service Objectives

Common objectives (examples)

1) To relate teaching activities to the nature of his natural, artificial and cultural environments of his localities, country (and in general - the whole world)
2) To relate teaching activities to the stages of physical, social, intellectual and emotional development of the child.
3) To know the cultural background and values of the people and make use of these in teaching
4) To be responsive and to evaluate suggestions and questions of others involved in the educative porcess
5) To pursue relevant areas of study to a greater depth
6) To know the place of science education within the whole of general education.
7) To be aware of the educational technology in teaching and be able to select the most appropriate for a particular course of studies.

Specific objectives for science teachers

Objectives concerned with teaching methods(examples)

1) To use a variety of teaching approaches including the ability to establish an atmosphere for inquiry
2) To be able to suggest or devise experiments (which include the use of materials available around the classroom or outdoor environment)
3) To be aware of learning theory and its application to the understanding and use of scientific concepts and process according to child's development.
4) To know a child's previous and present experiences (including those outside school) and the ability to use these in science teaching.

Objectives concerned with the discipline of I.S.

1) To have some common body of knowledge in the different areas of science in order to understand the wider aspects of what is to be taught,
2) To be able to design or describe a conceptual structure for I.S.
3) To be competent in the various processes of science.
4) To understand the relationships between science technology and society. And to attempt to perceive and over all picture of the affects of solving one problem on the total environment.

In-Service objectives

Many of the preservice objectives are also true of the inservice phase
Inservice training could serve the following functions:

a) Remedial
b) Enrichment
c) Developmental
d) Implementation

Much of the efforts at this stage should be devoted to achieving attitudinal objectives.

1) To be willing and able to meet professionally with colleagues and to work as a part of a team.
2) To have an understanding of the society of which the school forms a part, and willingness to interact with the other areas of society.
3) To be aware of various alternatives to the synethesizing of knowledge patterns and to be willing to change approaches to science teaching on the basis of this knowledge.

4) To be able to evaluate current trends in science education and to reject or accept the changes
5) To have the opportunity to consider and to develop curriculum ideas and to be given the time and resources to implement these.

Some of the objectives prepared earlier and not included in outline:

To develop manual skills for using simple hand tools to improvise science teaching aids from local resources if needed.

To find how to broaden present discipline-oriented courses so that cross-relationships are evident.

The group also considered Characteristics and competencies of the Teacher of Integrated Science.

Chairman: Rex Meyer Rapporteur: Elaine Ledbetter

WORKING GROUP Wg: THE RE-ORIENTATION OF SPECIALISTS FOR A ROLE IN THE TEACHING OF INTEGRATED SCIENCE

At all levels re-orientation is required in (1) attitudes (2) skills and (3) content. These targets interact, but the main task is to change attitudes.

The following types of specialists are identified as requiring re-orientation:

Elementary School

1. Subject specialist
2. Administrator
3. Supervisor, Inspector
4. Examiners, Evaluators
5. Parents, Community groups
6. UNESCO specialist

Secondary School

1. Subject specialist
2. Administrator
3. Supervisor, Inspector
4. Examiners, Evaluators
5. Support specialists: e.g. engineers, social scientists, etc.
6. Parents, community groups
7. UNESCO specialist
8. Other subject teachers, e.g. maths, history, etc.

Teacher Educator

1. Subject specialist
2. Administrator
3. Supervisor, Inspector
4. Examiners, Evaluators
5. Support specialists
6. Psychologists
7. Health educators
8. Special groups of engineers, medics, etc. overproduced by the local educational system.

ATTITUDES AND SKILLS REQUIRED:

The following table lists attitudes and skills identified as requirements for retraining:

1. An awareness of the "process" dimension of science and its value in the school curricula in contrast to the "content" dimension.
2. Ability to view any approach to integrated science in the context of the total education program both horizontally and vertically.
3. Examiners, inspectors and supervisors who understand the philosophy and objectives of integrated science curricula.
4. Willingness to accept the goals of integrated science in the context of one's own discipline.
5. Ability to formulate clearly stated objectives.
6. Sensitivity to the ultimate goals of science education.
7. Recognition of the limitations of one's background in a specialized area of science.
8. Sufficient knowledge of content in all areas of science for meaningful integration.
9. Skills in facilitating group dynamics, e.g. team teaching.
10. Skills in devising examinations appropriate for evaluating achievement in integrated science.
11. Skills appropriate for devising inservice programs that can effectively achieve the retraining of specialists in ways that are economical in time and money.

12. Skills in constructing instruments for evaluating the success of retraining programs.
13. Knowledge of available resources including human and environmental.

PROGRAMMES FOR RE-ORIENTING SPECIALISTS

Elementary

1. For Teachers:
   a. A training course in integrated science at a higher level than he will teach.
   b. Comparative studies of the goals and strategies of teaching integrated science.
   c. Special emphasis on practical skills for integrated science.
2. For head masters or inspectors or supervisors:
   orientation meetings, seminars, workshops and conferences to familarize administrators with course objectives and materials.
3. For other administrators or community groups:
   meetings to acquaint them with materials, philosophy and goals of the program and to enlist support.

Secondary

1. A P_3C programme:
   Problems
   Phenomena
   Processes
   Concepts
   involving horizontal and vertical interaction and a one-way flow of information from a higher level down.
   Could employ following methods:
   a. Team teaching both inside and outside classroom.
   b. Involvement of teachers in mini-projects, e.g. self-help research or experiments.
   c. Advice from visiting advisor, consultants or inspectors.
   d. Short summer courses
   e. Long courses (6 months)
   f. Scholarship system and low financial support.

Teacher Educator

1. Short in-service courses at universities with follow-up and seminars.
2. Use of media.
3. Longer courses at universities or colleges.
4. Preparation of special materials for teacher educators and teachers in schools.
5. Discussion groups in schools and teacher center.
6. Visiting schools to observe good programmes of integrated science.

EVALUATION OF EFFECTIVENESS OF RE-ORIENTATION PROGRAMMES

Elementary

1. Observational ratings of achievement of objectives by teachers and pupils.
2. Group evaluation of simulated lessons given by peers.

Secondary

Evaluation could be undertaken by:
1. pupils rating effectiveness of teaching.
2. Self evaluation by teacher.

3. Feedback conferences by groups of teachers using common material.
4. Attitudinal surveys of both pupils and teachers
5. Achievement testing of pupils.

3. Course evaluation by curriculum consultants.
4. Evaluation by the retrainer.

Continuous system of evaluation that never ends during the professional life of the teacher. See methods under elementary.

Teacher Educator

1. Self evaluation using standardized scales.
2. Evaluation by colleagues through reading, speaking, writing and activities in laboratory.
3. Student evaluation of trainers.

Working Group A

Chairman: Prof. Dolores Hernandez

Rapporteur: E. J. Wenham

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The role of science teaching improvement projects and centers in the preparation of teachers of integrated science.

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The group identified a number of existing functions of known science teaching centres and has attempted to collect examples of them which can be cited in the preparation of the final report. Of thirteen centres surveyed, half are involved in pre-service training. In this respect their role appears to be one of mediation and integration between the teacher training institution providing the professional training and the institution providing the scientific (academic) training. If this role is to be played effectively, it is important that the staff of the academic institution providing the scientific training should be involved in the work of the centre.

The in-service training of teachers provices an obvious function for a science education center which can be expected to provide a suitable environment for such work. Twelve of the thirteen centres worked in this field.

Teacher educators themselves can expect to find support from a Centre through involvement in seminars and conferences as well as by the use of the facilities that such a centre might provide. These might include school-type laboratories and equipment, workshops, resource centres and professional services of several kinds. The Centre staff might include experienced teachers representing areas of education and the separate scientific disciplines as well as integrated science together with professional support staff, both technical and administrative.

Science teaching improvement projects were seen to be excellent vehicles for affective interaction between all those involved in the process of science education and of particular importance in improving the quality of teaching and learning. A teacher working with a project team, whether as a developer or a trial teacher was engaged in a more effective form of in-service education. When projects were being implemented on a wider scale, the project team would be wise to provide materials designed specifically for use in both pre-service and in-service training.

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All training programmes, whether pre- or in-service, shall be consistent with the best current practice in integrated science teaching and learning.

The survey of thirteen centres from twelve countries revealed that nine were located within universities. It was noteworthy that most of the facilities listed by the group were provided by the centres.

These functions were:

1. The pre-service preparation of teachers
2. In-service education
3. Providing a consultation service to (a) schools (b) higher education institution (c) the community (d) government (local or central)
4. (a) Undertakes research relevant to other functions
   (b) Provides for liaison between schools, teacher training institutions and research teams in (i) research in science education (ii) curriculum development
5. Produces instructional materials for (a) curriculum development projects (b) other needs
6. Maintains a library of resource material
7. Evaluates (a) course materials at school level
   (b) teacher education courses
8. Designs and builds prototype equipment
9. Organizes science fairs and clubs
10. Provides courses for teacher educators
11. Initiates other science centers
12. Utilizes radio/TV for the promotion of projects
13. Provides guidance in the field of assessment
14. Provides facilities for outside groups of students or teachers for meetings, conferences, etc.
15. Provides for communication with Science Teacher Associations.

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